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Maternal size and age affect offspring sex ratio in the solitary egg parasitoid *Anaphes nitens*

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Abstract

In this study, the effects of maternal age, diet, and size on offspring sex ratio were investigated for the solitary egg parasitoid, *Anaphes nitens* Girault (Hymenoptera: Mymaridae), both outdoors, during the winter, and inside a climatic chamber under favourable constant conditions. During the winter of 2005–2006, each of seven groups containing 40 1-day-old females was mated and randomly distributed among two treatments: (treatment 1) a droplet of undiluted honey ad libitum + one fresh egg capsule of the snout beetle *Gonipterus scutellatus* Gyllenhal (Coleoptera: Curculionidae) as host; (treatment 2) drops of water + one fresh egg capsule of *G. scutellatus*. We recorded the lifetime fecundity, the daily sex allocation, and the lifetime offspring sex ratio to study the existence of a relationship with maternal characteristics. Moreover, we assessed the effect of location (outdoors vs. indoors) and group (groups are representative of early, mid, and late winter) on sex ratio. The most important factor that biased the sex ratio was maternal body size: larger females of both treatments produced more female offspring. As females of *A. nitens* could gain more advantage than males from body size, larger mothers have a higher fitness return if they produce more daughters. The effect of the treatment was significant: starved females produced more females. Location and group were not significant. Fecundity and sex ratio were age dependent. Old mothers that received honey (treatment 1) had fewer offspring and a more male-biased offspring sex ratio, probably due to reproductive senescence and sperm depletion. Starved females (treatment 2) experienced reproductive decline earlier, perhaps because they invested more energy in maintenance rather than in reproduction.

Introduction

In parasitic Hymenoptera, mated females store sperm in the spermatheca and can manipulate the sex ratio (males/total offspring) of their progeny by controlling fertilization during oviposition. The haplodiploid sex-determination system (arrhenotokous parthenogenesis) provides the mothers with a mechanism to control progeny sex ratio, because males develop from unfertilized eggs (haploid) and females from fertilized eggs (diploid) (Gould & Bolton, 1996). If we measure maternal fitness by adding the number of mates of her sons to the lifetime number of daughters she has produced, then the benefit of producing males and females is not equal, but depends on offspring mating opportunities (Godfray, 1994). Female-biased sex ratios are common among hymenopterous parasitoids that live in subdivided populations, with a few foundresses inside the patch and some degree of sib-mating (Hamilton, 1967; Antolin, 1993; Hardy, 1994).

In the context of the study of sex allocation, attention has been focused especially on resources (host and food) quality and abundance, to which the females are expected to respond in an adaptive way. The consequences of host abundance (Bai & Smith, 1993; King et al., 1995), host size (Charnov et al., 1981; King & Lee, 1994; Heinz, 1996; Napoleon & King, 1999), host age (King, 2000), host species (King, 1987; Uçkan & Gülel, 2002), and host quality (healthy vs. parasitized) (King, 1996a; van Baaren et al., 1999) on sex ratio have been intensively studied during

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